Bulletin B-166-8

WOOD FLOUR
AND
MOLDED WOOD FLOUR PRODUCTS

Manufacturing Opportunities in Georgia

Prepared for
The Georgia Department of Commerce
Abit Massey, Director

by
Tze I. Chiang

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia

Project B-166-8

WOOD FLOUR AND MOLDED WOOD FLOUR PRODUCTS

Manufacturing Opportunities in Georgia

Prepared for
The Georgia Department of Commerce
Abit Massey, Director
100 State Capitol
Atlanta, Georgia

by

Tze I. Chiang

Industrial Development Branch
Engineering Experiment Station
Georgia Institute of Technology
January 1960

Table of Contents

Tables

Appendices

Foreword

As often happens, changes in the industry under study have taken place during the period in which this report was being prepared (August 1959 to January 1960.) In this instance, a substantial increase in the manufacturing capacity of existing toilet seat manufacturing facilities has taken place in Georgia. As a result, production now is approximately equal to the regional market.

The opportunity for exporting toilet seats to the western part of the country still exists if a local wood flour supply can be developed. The need for a wood flour plant in Georgia actually has become more acute than ever as a result of the increase in manufacturing capacity.

It is hoped that analysis of the feasibility of establishing a wood flour plant can be completed in the near future. In the meantime, inquiries regarding this report are invited.

Kenneth C. Wagner, Head
Industrial Development Branch

Acknowledgments

The author is indebted to so many people in the different fields of work who have generously supplied information for this study. Without their cooperation, this report would be impossible.

Special thanks are due to Mr. H. F. Royal and Mr. Robert Royal, of Royal Seats, Inc., for their information about the toilet seat industry and their interest in this study. Mr. F. J. Donohue, Monsanto Chemical Co.; Mr. M. E. Ginaven, The Bauer Bros. Co.; Mr. K. R. Sterrett, Sprout, Waldron & Co., Inc. and Mr. A. J. Kirsch, American Cyanamid Co. provided data dealing with molded products and wood flour. Mr. R. W. Hutton, Toilet Seat Manufacturers Association, Inc.; Mr. E. A. Bogusz, Domestic Engineering Co., and Mr. R. W. More, Hooker Chemical Corp., gave many useful data of the toilet seat industry.

Thanks are due to Mr. W. G. Talley, Talley Veneer and Crate Co., Adel, Georgia, for providing 100 pounds of wood chips for the purpose of technical testing. Mr. J. R. Saucier, Georgia Forestry Commission, and the 56 chambers of commerce or the industrial development groups in the different localities in Georgia provided the names and addresses of various woodworking concerns for the mail survey.

The members of the Industrial Development Branch provided many assistances in the study. The author is grateful to Dr. Walter P. Kennon for reviewing the manuscript and his valuable comments. Mr. Robert E. Van Geuns participated in the interviews during a trip to the New York and Philadelphia cities. Dr. Kenneth C. Wagner extended much help in contact, consultation and editorial work. Mrs. Carolyn Plummer typed the manuscript and Mrs. Betty Jaffe patiently prepared the final report.

Summary

Molding wood flour into articles creates a new field for the utilization of wood waste. A low cost manufacturing method makes the products competitive. Molded toilet seats are the major product made of wood flour. Other molded products such as furniture parts, dishes, croquet balls, etc. have had increasing sales in the last few years.

The toilet seat market consists of two segments--new construction and replacement. These two segments of the market are equally divided at the present. The market for new construction is indicated by the sales of water closet bowls. The market for replacements is indicated by the ratio of the sales of toilet seats and the sales of water closet bowls in each year. The total toilet seat market is estimated at 9,106,000 units in 1960; 9,988,000 units in 1965; and 11,048,000 units in 1970.

The southeastern market for toilet seats is estimated at 979,000 units in 1960. Local production capacity equals only 60 to 70 per cent of the regional market. Therefore, a rather large part of the market is supplied by manufacturers outside the region. There is a market to support an additional small plant with annual capacity of 150,000 units in the state. The equipment costs for such a plant are estimated between $59,000 to $89,000. A larger southeastern plant to reach the national market would be profitable if a low-cost supply of wood flour can be developed.

In Georgia, the current demand of wood flour for molding is estimated between 2,000 to 3,000 tons annually. The supply comes largely from Wisconsin and New York with a high transportation cost. If a supply with low transportation cost can be developed, the use of wood flour in the state can be more than doubled.

The problems of developing a wood flour plant in Georgia are wood species, requirements of wood residues, and specialized technical skill in managing a wood flour plant. Georgia has poplar and gum for wood flour. The wood residue in the Atlanta area and at Adel, Georgia, can meet most conditions required for manufacture. The current need is a competent person to take a lead in the pioneer work.

A plant model with 2,000 pound capacity per hour is analyzed. A total investment of $241,000 to $306,000 is estimated. The total production cost per ton is estimated to range from $28 to $36, while the f.o.b. mill price per ton is $35. The payout period for fixed investment will be 21 years for one shift, six years for two shifts, and three years for three shifts.

INTRODUCTION

Why Wood Flour and Molded Products?

Molded wood flour opens a new field for wood waste utilization as well as a new area for product development. Wood obtained from waste can be ground into very fine wood flour for such molding as chair seats, backs and arms, desk tops, salad bowls, croquet balls, toilet seats, etc. Increasing sales indicate that these products are being accepted. A new area in wood waste utilization has been opened.

A major advantage of molded wood flour, in comparison with other materials, is the lower manufacturing costs. The lower costs are due to a cheaper raw material, less waste in processing, increased rate of production, and fewer finishing operations.

Scope and Purpose of the Study

The motive of this report springs from the search for a wood flour supply in Georgia. In order to understand the related situation involved, one must have a clear picture of all products made of wood flour first. For this reason, a brief summary on molded wood flour products is introduced. The production and distribution of toilet seats, the major molded wood flour product, are analyzed. Finally, the demand of wood flour in the state is presented. For simplicity, molded wood flour products will be called "molded products."

The major purpose of this report is to point out the opportunities and problems involved in developing wood flour and molded products in Georgia. Information pertaining to market potentials, wood raw materials and requirements for successful manufacture are presented and discussed. These data will be useful to those who are looking for small manufacturing opportunities in rural Georgia.

Data Obtained

Six companies were interviewed in order to obtain information on marketing and production. Included were three toilet seat plants, one wood flour plant and two chemical corporations in the nation. Four machine manufacturing companies were consulted for production and equipment costs.

A state-wide mail survey was conducted in September 1959 in the hope of finding several Georgia locations where there are enough wood residues

suitable for wood flour manufacture. The survey was confined to the large woodworking concerns which were recommended by the local chambers of commerce and the Georgia Forestry Commission or selected from the Georgia Manufacturers, 1958. A total of 77 questionnaires was mailed and 33 were returned.

A limited amount of literature dealing with wood flour and molded products was reviewed. Statistical data on households and construction were collected for the purpose of estimating market potentials.

I. MOLDED PRODUCTS

Some Characteristics of Molded Products

Molded products are made by pressing wood flour mixed with a resin adhesive in a heated mold. The mold is hydraulically pressed until thermostat shaped articles are completed. Pressing cycles range from six to 15 minutes, depending upon density, thickness and shape of products. After molding is completed, very little finishing is required.

Not all products can be made by molding wood flour. Requirements of shape and properties limit to a great extent the product that can be made. In general, the shape must be reasonably flat, with no excessively thin areas and no great changes in cross sections. In comparison with solid wood products, molded products are generally denser, harder, and have a higher gloss. Flexural strength, screw holding power, and impact resistance vary according to manufacturing variables, such as wood species, particle size, resin, pressure, temperature, wood moisture and cure time. Thus, molded products are versatile and flexible in properties.

Depending on the properties needed, wood flour for molded products ranges generally in fineness from 40 to 80 mesh or more. Coarse wood flour mix gives greater impact resistance and is generally used for the core. A finer wood flour mix will produce a denser, smoother, and harder surface.

Molded Products and Their Market Status

The first molded product to appear was toilet seats in 1945.[1/] Through the 1950's, production of toilet seats converted gradually from solid wood to wood flour molding. The conversion is almost complete at the present stage.

Owing to experience and the improved technology gained in toilet seat manufacture, the technique of wood flour molding is applied to the production of different products. The Monsanto Chemical Company lists various products in nine areas:

1. Housewares: salad bowls, lazy susans, dishware, TV serving trays, flower pots, and trays.
2. Furniture: backs, seats and tops of chairs and desks, tables, cabinet ends, bookcases, and various decorative pieces.

1/ Midyette, A. L., "Wood Particle Molding," Forest Products Journal, Vol. VII, No. 1, January 1957.

3. Packaging: drafting tools, delicate industrial parts, electronic tubes and capsules, gun cases, and other containers.

4. Electrical: switch boxes, fuse boxes, transformer shields, and motor bases.

5. Sporting Equipment: croquet balls, bowling balls, and shuffleboard discs.

6. Toys and Novelties: life-like automobiles, planes and other educational or construction toys.

7. Appliances: handles, bases and mounting boards for electric fans, lamps, and motors.

8. Accessories: toilet seats, hamper tops, counters and cabinets for bathroom use.

9. Industrial: pulley belt, equipment and machine supports, coasters, skids, protective machine guards, and core stock for floors.

The wood flour molding technique as applied to products other than toilet seats has only a few years' history. Requirements of properties and specifications are different. Some molded products can meet the market competition of other materials; other molded products have not been as successful. An improvement in molding technology will generate a greater expansion of the market for molded products.

Molded products with some degree of market success are bowling and croquet balls, shuffleboard discs, shoe heels, instrument bases, dishes and salad bowls, lazy susans, furniture components, paper roll plugs, hamper trays, truck backs, toys and casket tops.[1/] So far, toilet seats are still the major product using wood flour molding. Furniture components, however, have a potential for expansion. Table 1 indicates the market for various molded products by the respective percentages of resin consumed in 1957.

There are 30 wood flour molders in the United States.[2/] Thirteen of them are toilet seat manufacturers.[3/] In the Southeast,[4/] there are three wood flour molders--two manufacturing toilet seats and one manufacturing paper roll plugs. The manufacture of molded products is still in the early stages of development in this region.

1/ Donald A. Watson, "Granulated Wood Molding," Forest Products Journal, Vol. IX, No. 9, September 1959.

2/ Ibid.

3/ There are 25 toilet seat manufacturers in the states, 13 of them are using wood flour as their raw materials.

4/ Includes Alabama, Florida, Georgia, North Carolina, South Carolina, and Tennessee.

Table 1

THE U. S. PERCENTAGES OF RESIN CONSUMED
FOR MANUFACTURING MOLDED PRODUCTS, 1957

Product	Percent of Total Resin Consumption
Toilet Seats	73.0
Furniture Components	13.0
Dishes	4.8
Croquet Balls	3.4
Lazy Susans	3.1
Bowling Balls	1.7
Paper Roll Plugs	0.5
Shuffleboard Dishes	0.3
Toys	0.2
Total	100.0

Source: Forest Products Journal, Vol. IX, No. 9.

Due to the great diversity of molded products, it is impossible to make a meaningful estimate of market potentials for all products. Since toilet seats are the major product using wood flour molding and there is a plant in Georgia, they were selected for detailed study.

II. TOILET SEATS

The National Market

The marketing figures of toilet seats are available from 1956 to 1958. (See Table 2.) The current demand for toilet seats is estimated at 9,000,000 units annually. In 1958, molded seats (sprayed and sheet covered) accounted for 79 per cent of the total market, plastic seats 20 per cent and other seats 1 per cent.

Table 2

THE U. S. SHIPMENTS OF TOILET SEATS, 1956-58

Year and Product	Shipment (No. of Units)	Value ($1,000)	% of Shipment	Avg. Value Per Unit (Dollar)
Total, 1956	7,422,045	29,047	100	3.91
Sprayed, molded or wood	5,064,930	15,191	68	3.00
Sheet covered, molded or wood	657,585	3,919	9	5.96
Plastic, solid and cored	1,439,145	8,902	19	6.19
All other	260,385	1,035	4	3.97
Total, 1957	7,383,831	27,749	100	3.76
Sprayed, molded or wood	5,189,395	14,841	70	2.86
Sheet covered, molded or wood	584,413	3,234	8	5.53
Plastic, solid and cored	1,356,935	8,666	18	6.38
All other	253,088	1,008	4	3.98
Total, 1958	8,292,723	28,702	100	3.46
Sprayed, molded or wood	5,949,785	15,231	72	2.56
Sheet covered, molded or wood	601,962	3,132	7	5.20
Plastic, solid and cored	1,687,243	10,096	20	5.98
All other	53,733	243	1	4.52

Source: Facts For Industry

There have been two dominant trends in the market for toilet seats. The first was the decline in sales of solid wood seats and the expansion of molded seats. The second was the demand for plastic seats. These trends are noticeable in Table 2, although it covers only a three year period. All other seats such as solid wood, rubber and steel, declined from 4 to 1 per cent, while sprayed molded seats increased from 68 to 72 per cent. However, sheet-covered molded seats declined from 9 to 7 per cent. In the same period, plastic seats gained 1 per cent of the total market.

The expansion of molded seats at the expense of solid wood seats was largely due to lower molding cost compared with the cost of solid wood. The price of molded seats declined persistently while their demand increased. (See Table 2.) On the other hand, the value per unit of all other seats increased year after year, but their market declined drastically. The sales volume of plastic seats fluctuates inversely with price.

The market for toilet seats is composed of two separate demands--the demand for new construction and the demand for replacements. The demand of toilet seats in new construction is indicated by the total sales of various water closet bowls since each bowl requires a seat. The sales (shipment) of water closet bowls has a multiple correlation with residential and non-residential construction from 1946 to 1958.[1/] Based on this relationship and a projection of construction, the sale of closet bowls and those of toilet seats in new construction can be projected.

The demand of toilet seats for replacements is indicated by the difference of toilet seat sale and the sale of water closet bowls in each year. Table 3 indicates the ratios of toilet seat shipment (sale) and water closet bowl shipment (sale) from 1956 to 1958. The ratio increased from 1.59 in 1956 to 1.96 in 1958. It indicates that the replacement market is increasingly important and is approximately equal to the demand for the new construction market at the present time.

1/ See the details of the multiple correlation in Appendix A.

Table 3

RATIOS OF TOILET SEAT SHIPMENT TO
WATER CLOSET BOWL SHIPMENT, 1956-58

Year	Toilet Seat Shipment (No. of Units)	Water Closet Bowl Shipment (No. of Units)	Ratio
1956	7,422,045	4,681,140	1.59
1957	7,383,831	4,223,467	1.75
1958	8,292,723	4,231,633	1.96

Source: Facts For Industry

From this analysis of the new construction and replacement markets, total demand for toilet seats can be projected. Demand of toilet seats is estimated at a little over 9,000,000 units in 1960, close to 10,000,000 units in 1965, and 11,000,000 units in 1970. (See Table 4.) The forecast tends to be conservative due to the estimated 1:1 ratio of toilet seat sales for new construction and for replacement. In following the trend, this ratio is likely to be greater than 1:1 in the forecast period.

Table 4

FORECAST OF U. S. TOILET SEAT DEMAND,
1960, 1965, AND 1970 a/

Year	Total Demand (1,000 Units)	For New Constructions (1,000 Units)	For Replacements (1,000 Units)
1960	9,106	4,553	4,553
1965	9,988	4,994	4,994
1970	11,048	5,524	5,524

a/ See the details in Appendix B.

The future market of toilet seats is optimistic for several reasons. First, new construction activities are expected to increase due to the economic and population growth of the nation. Second, the declining price of molded seats will promote a greater replacement market. Third, the demand of toilet seats exceeded the supply in 1958. (See Table 5.) Most of the toilet seat plants are operated at full capacity; several are adding new capacities.

Table 5

THE U. S. TOILET SEAT PRODUCTION AND SHIPMENT
1956-58

Year	Production (No. of Units)	Shipment (No. of Units)	Shipment as a Percentage of Production
1956	7,616,428	7,422,045	97
1957	7,399,494	7,383,831	99
1958	8,231,651	8,292,723	101

Source: Facts For Industry

The Regional Market

The market of six southeastern states[1/] is estimated at 979,000 units in 1960. The estimate is based on construction expenditures and the number of dwelling units. For the six states, the construction expenditures are equal to 10 per cent of the U. S. total, and the number of dwelling units is 11.5 per cent of the U. S. total.[2/]

There are two toilet seat producers in the Southeast and 25 in the nation. (See Map 1.) The current plant production capacity (October 1959) in the Southeast can meet only 60 to 70 per cent of the regional market. There is a market for plant expansion in the Southeast. The manufacture of toilet seats is heavily concentrated around the Great Lakes and New England. The large areas in the Northwest and Southwest have no toilet seat manufacture.

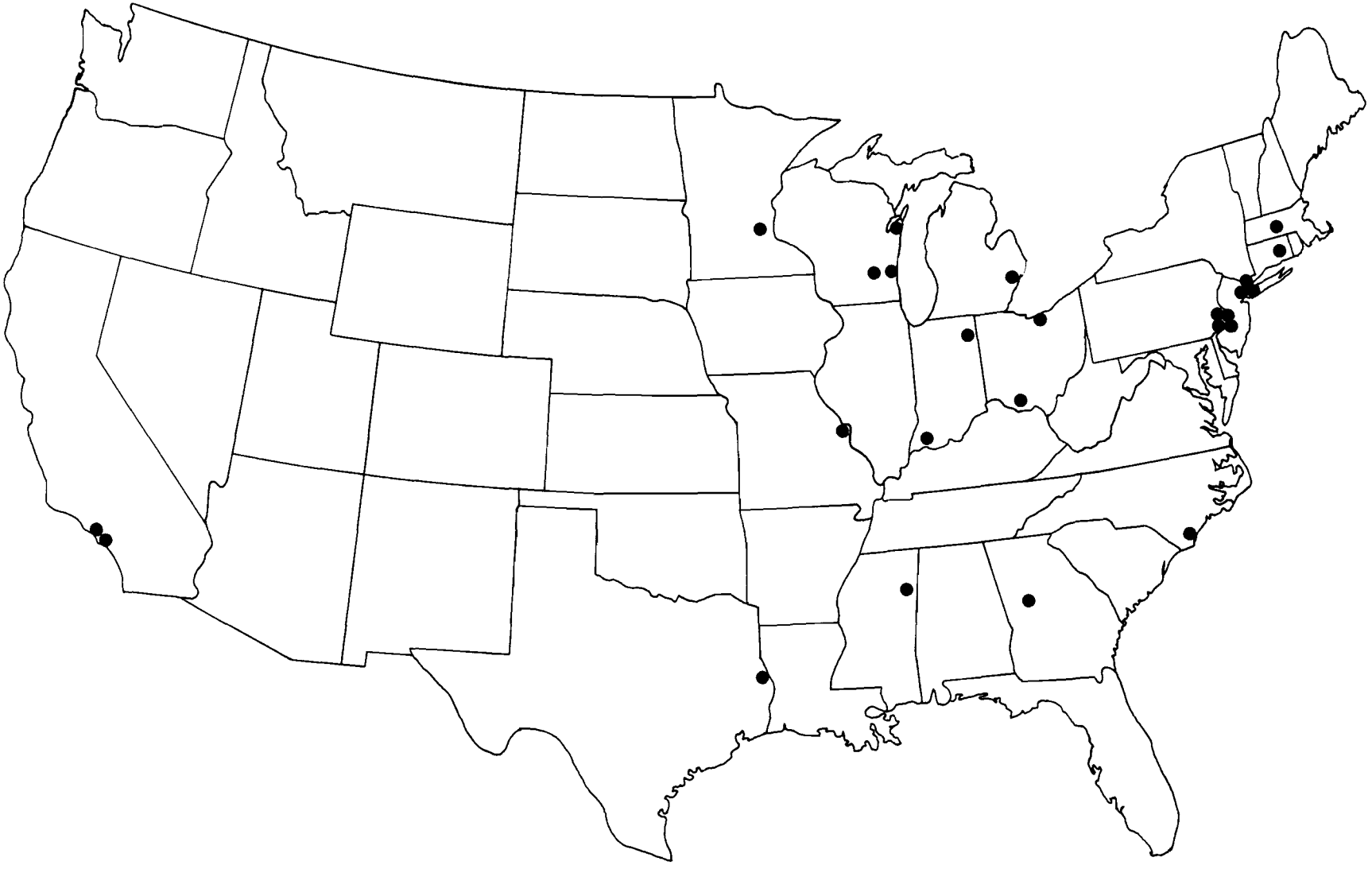
A plant in the Southeast can sell to these areas as economically as a northern plant if wood flour can be supplied locally. The flour supply in the Southeast comes largely from Wisconsin and New England. High transportation cost puts the southeastern plants at a disadvantage in the market. However, a supply of wood flour is developing in North Carolina, and Georgia is beginning to develop a supply. Local supply of wood flour will have a direct impact not only on the toilet seat industry but also on the development of other molded products in the Southeast.

1/ Includes Alabama, Florida, Georgia, North Carolina, South Carolina and Tennessee.

2/ See the details in Appendix C.

MAP 1

DISTRIBUTION OF THE U. S. TOILET PLANTS, 1959



Georgia can support one or two additional small toilet seat plants to supply the regional market. A plant capacity around 150,000 units annually will be adequate. Small towns with an ample supply of wood residues which can be used for wood flour manufacture are logical sites for a plant location. A larger plant in the state to supply the national market depends upon the possibility of acquiring low cost wood flour--presumably a local supply.

Manufacturing Plant

The design of the plant for manufacturing toilet seats depends upon the production volume, product properties, and the type of processing methods. Requirements for a small manufacturing plant are listed as follows:

1. Plant Capacity -- six molds and three presses with annual capacity of 168,000 units at 300 working days a year and three shifts a day.
2. Plant space -- about 3,000 square feet.
3. Type of product -- molded seats (sprayed).
4. Equipment costs:

Three molding presses @ $10,000	$30,000
Six molds @ $1,500 to $5,000	$ 9,000 to $30,000
Auxiliary Equipment	$20,000
Total	$59,000 to $80,000

5. Materials:

   Wood flour -- 80 mesh or finer; moisture content 5 per cent or less; wood species maple, white pine or others; cost, f.o.b. $40 per ton from North Carolina or Texas.

   Resin -- Urea, phenolic or melamine depending upon product properties needed. Powdered resins used as binders cost from 21¢ to 43¢ per pound, delivered, depending on type.

6. Formulation:

Wood flour:	60 to 90 per cent of blend.
Resin:	10 to 40 per cent of blend.
Pigment:	as required.

7. Processing:

Mold temperature	265^{o} - 350^{o} F.
Mold pressure	500 - 1,200 psi
Cure time	6 to 15 minutes
Raw material shrinkage	5 to 10 per cent

8. Labor -- 3 to 4 production workers per shift.

Companies suggested as sources for further information are:

Monsanto Chemical Company
Plastic Division
Springfield 2, Massachusetts

American Cyanamid Company
Plastic and Resins Division
30 Rockefeller Plaza
New York 20, New York

Hooker Chemical Corporation
Durez Plastic Division
North Tonawanda, New York

III. WOOD FLOUR

A Wood Flour Plant in Georgia

According to current estimates, Georgia annually consumes 2,000 to 3,000 tons of wood flour with 80 mesh or finer for toilet seat manufacture alone. This consumption can be more than doubled if a wood flour supply can be obtained at a low transportation cost. The current supply comes largely from Wisconsin and New York with a transportation cost equivalent to two thirds of the f.o.b. price.[1/] A high transportation cost of wood flour coupled with a highly competitive pricing for the toilet seats puts the local seat producer at a disadvantage. The need for a local supply of wood flour already exists.

The production of wood flour is highly concentrated in the Great Lakes and New England states, which have the desirable wood species. In the South there are six producers--five in Texas and one in North Carolina. The North Carolina plant is in the development stage. In Texas wood flour is made from Ponderosa white pine, Douglas fir, and oaks. This wood flour is not currently used for molded products in Georgia. The newly developed wood flour from North Carolina is made of maple and poplar. North Carolina could become an important source of supply to Georgia users if a local supply is not developed.

Wood flour producers generally are specialized in one or two types, due to rigid and exact consumer requirements. For this reason, the wood flour assumed in this analysis is 80 mesh or finer, suitable for molded products.

Problems in Developing A Wood Flour Plant in Georgia

There has been a search for wood flour supply in Georgia by some private concerns, but several problems remain unsolved. The problems involved are wood species, requirements of wood residues, and specialized managing experience. These problems are discussed separately.

Wood species. The most desirable wood species for wood flour are white pine, aspen, and hemlock. However, maple has been used predominately for

---

1/ "The cost of shipment of wood flour is somewhat more than for sawdust, wood flour being so classed and taking a higher rate when 75 per cent of the material passes through 60 mesh" as quoted from Wood Flour, Forest Products Laboratory, Madison, Wisconsin, Forest Service, U.S.D.A.; Report No. 1666-9, May 1956.

toilet seats. Gum can be used if mixed with other species. Yellow pine cannot be used due to the high rosin content. Oak and dark hardwoods are not desirable from the color standpoint. Yellow poplar, according to a recent laboratory test by a chemical company, is not most satisfactory.

Southern yellow pine, gum, and yellow poplar are the dominant species in Georgia. There is little maple and white pine in the state. Although yellow poplar and gum are available in quantity, their usefulness for molded products is less desirable. However, Georgia wood-using industries import a considerable quantity of fir, maple, and white pine each year which are useful for wood flour. Research on wood flour under consideration by Georgia Tech's Engineering Experiment Station may also discover a method for removing some obstacles in utilizing local wood resources.

Requirements of wood residues. The profitability of the wood flour industry depends upon a favorable cost ratio between wood flour and other substitute materials. For example, molded products cost about $3.40 per cubic foot, while a general purpose phenolic molding is $19 per cubic foot.[1/] In order to maintain this favorable ratio, the industry has to keep manufacturing costs such as raw materials, power, labor, etc., at a low cost. Sawdust and shavings are commonly used. They should be clean, dry, free of bark and separated by species. Otherwise, there is an increase in cost from usage of poor quality material. Available quantity and stability of supply are also prime considerations. A 10 to 15 ton supply per day will be required for a minimum but economic sized operation.

From a mail survey conducted in September 1959, only one place in the state--Adel, Georgia--is presently in a position to meet most of the conditions listed above. The Atlanta area, however, is believed also in a position to meet the conditions. In other locations, two common phenomena appeared--wood residues were mixed and they are now burned as waste. An adequate treatment of wood residues in order to facilitate their utilization for wood flour seems to be needed by most woodworking concerns in the state. Appendix D gives the available wood residues by 15 respondents who had stated their supply quantitatively and qualitatively. A more detailed survey on the raw materials for wood flour should be followed if such a need is requested by any interested concerns.

1/ Donald A. Watson, op. cit.

Specialized managing experience. Due to different, rigid, and exact requirements of wood flour by customers, manufacture becomes a highly specialized business. Technical skill and experience in business are required for managing a new plant. Inducing competent persons in the industry to be interested in the local problems of molding may be a practical step to be taken in bringing in a wood flour plant in Georgia.

Investment and Return for a Wood Flour Plant

An economic sized operation of a wood flour plant ranges from 1,000 to 2,000 pounds output capacity per hour. There is a market in Georgia to support a plant of about 2,000 pounds per hour capacity. Therefore, this sized plant is assumed for analysis. The product is 80 mesh wood flour suitable for molded products.

All cost figures used in this study are approximations. It is assumed that the model plant is located either in the Atlanta area or at Adel, Georgia, for a wood raw material supply. Equipment and operating cost data were obtained from machine manufacturers, but without a specific commitment or guarantee that a plant could be built and operated for the specific costs given. It should be pointed out, however, that each plant is a special problem with various conditions of raw material and other operating conditions.

For the model, the annual capacity is estimated at 7,200 tons on 300 working days a year and three shifts a day. Equipment costs plus transportation and erection are estimated at $162,500. Land and building are estimated at $27,000. All costs and returns are calculated on three different shift basis. The f.o.b. mill price of wood flour made by this model plant is $35 per ton. Variable costs are estimated at $23.67 per ton. Sales would have to be 1,462 tons annually to cover the out-of-pocket costs and 2,535 tons annually to cover total costs.

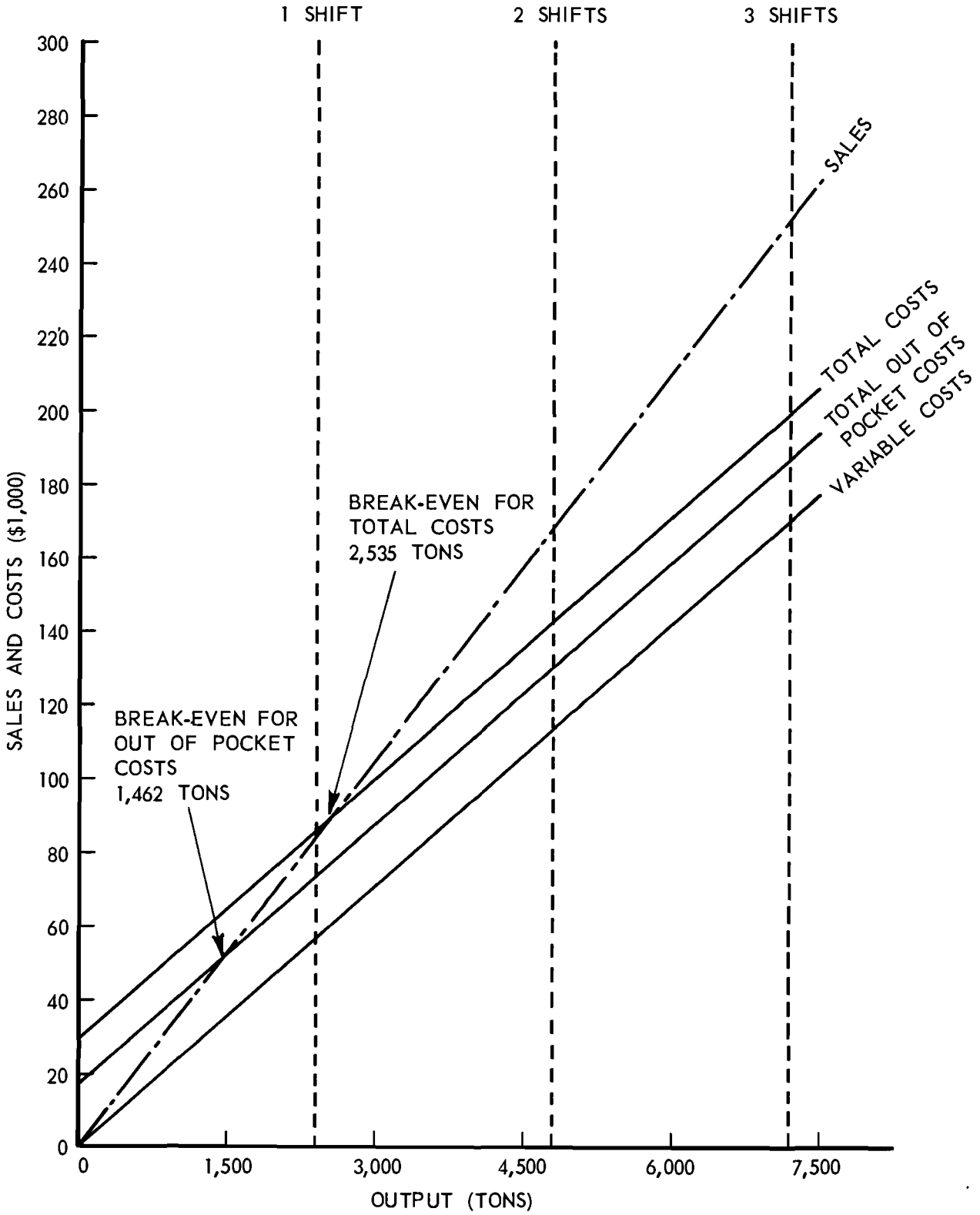
A summary statement of investment, sales, operating cost, and return of this model is presented, followed by a break-even chart. After the summary statement and break-even chart, there are detailed statements of income, expenses, and investment. The reader may go from the summary statement to any degree of detail desired.

ANNUAL SUMMARY STATEMENT

A MODEL WOOD FLOUR PLANT WITH A 2,000 POUND OUTPUT CAPACITY PER HOUR

Income (Schedule A)		1 Shift	2 Shifts	3 Shifts
Unit Sales at Capacity		2,400 tons	4,800 tons	7,200 tons
	Per Ton			
Sales	$35.00	$ 84,000	$168,000	$252,000
Variable Costs	23.67	56,808	113,616	170,424
Variable Profits	$11.33	$ 27,192	$ 54,384	$ 81,576
Out-of-Pocket Fixed Costs		17,253	17,253	17,253
Cash Income		$ 9,939	$ 37,131	$ 64,323
Non-cash Fixed Costs (Depr.)		11,833	11,833	11,833
Net Income		$- 1,894	$ 25,298	$ 52,490
Break-Even (Tons)				
To Cover Out-of-Pocket Costs		1,462	1,462	1,462
To Cover All Costs, Including Depr.		2,535	2,535	2,535
Investment				
Fixed Investment (Schedule B)		$208,450	$208,450	$208,450
Working Capital (Schedule C)		32,480	64,960	97,440
Total		$240,930	$273,410	$305,890
Per Cent Return				
On Fixed Investment		-0.91%	12.14%	25.18%
On Total Investment		-0.79%	9.25%	17.16%
Payout Period				
Period for Cash Income to Cover Fixed Investment		21 Years	6 Years	3 Years

BREAK-EVEN CHART



ANNUAL STATEMENT ON THE MODEL PLANT'S INCOME AND EXPENSE

Schedule A

		1 Shift	2 Shifts	3 Shifts
Unit Sales at Capacity		2,400 tons	4,800 tons	7,200 tons
	Per Ton			
	$35.00	$ 84,000	$168,000	$252,000
Variable Costs				
Wood (Schedule A-1)	$ 5.60	$ 13,440	$ 26,880	$ 40,320
Labor (Schedule A-2)	8.67	20,808	41,616	62,424
Overhead (Schedule A-3)	9.40	22,560	45,120	67,680
Total Variable Costs	$23.67	$ 56,808	$113,616	$170,424
Variable Profits	$11.33	$ 27,192	$ 54,384	$ 81,576
Fixed Costs				
Out-of-Pocket Fixed Costs				
Salaries (Schedule A-4)		$ 11,000	$ 11,000	$ 11,000
Insurance (Schedule A-5)		2,084	2,084	2,084
Property Tax (Schedule A-5)		4,169	4,169	4,169
Total		$ 17,253	$ 17,253	$ 17,253
Cash Income		$ 9,939	$ 37,131	$ 64,323
Non-Cash Fixed Costs				
Depreciation (Schedule A-5)		$ 11,833	$ 11,833	$ 11,833
Net Income		$- 1,894	$ 25,298	$ 52,490

Wood Cost — Schedule A-1

1 ton of sawdust or shelvings cost $5.00 at weight of 2,000 pounds with 6 per cent moisture and free of bark.

1 ton yield:

$2{,}000 \times 0.90 = 1{,}800$ pounds (10 per cent process loss)

Cost per pound:

$\$5.00 \div 1{,}800$ pounds $= \$0.0028$

Cost per ton:

$5.60

Labor Cost — Schedule A-2

Machine operator	$1.50/hour
Odd jobs	$1.00/hour

Operation	No. Men	No. Shifts	Hours	Daily Cost
Machine	4	3	96	$144
Warehouse	2	2	32	32
Yard	2	2	32	32
Total				$208

Labor cost per ton = $208 ÷ 24 tons = $8.67

Variable Costs — Schedule A-3

Supplies	$3.00/ton
Power: 400 H.P., 16¢ per kilowatt	6.40/ton
	$9.40/ton

Salaries — Schedule A-4

Plant Manager	$8,000
Stenographer	3,000
	$11,000

Annual Depreciation and Other Fixed Charges — Schedule A-5

	Original	Annual Charge
Building depreciation at 20 years	$ 20,000	$ 1,000
Equipment depreciation at 15 years	162,500	10,833
Property taxes at 2 per cent of investment	208,450	4,169
Insurance at 1 per cent of investment	208,450	2,084
Total		$18,086

Fixed Investment — Schedule B

Building		
Construction 5,000 sq. ft., $4/sq. ft.	$ 20,000	
Land and foundation	7,000	
Total		$ 27,000
Equipments		
All equipments and auxiliaries	$125,000	
Transportation and errection	37,500	
Total equipment		$162,500
Total fixed investment, estimated		189,500
Contingency (10 per cent)		18,950
Total fixed investment		$208,450

Working Capital — Schedule C

	1 Shift	2 Shifts	3 Shifts
4 months wood supply	$ 4,480	$ 8,960	$13,440
2 months finished goods	14,000	28,000	42,000
2 months invoice payable	14,000	28,000	42,000
Total	$32,480	$64,960	$97,440

Suggested Organizations for Inquiring Purposes

Forest Products Laboratory
Forest Service, U.S.D.A.
Madison 5, Wisconsin

The Bauer Brothers Company
Springfield, Ohio

Sprout, Waldron S. Company, Inc.
Muncy, Pennsylvania

Appendix A

MULTIPLE CORRELATION OF WATER CLOSET BOWL SHIPMENT
TO RESIDENTIAL AND NON-RESIDENTIAL CONSTRUCTIONS

Year	Shipment of Water Closet Bowls-Vitreous China (thousand units) Y	Residential Construction (million dollars) X_1	Non-Residential[a/] Construction (million dollars) X_2
1946	2,136	5,126	3,831
1947	2,559	7,735	3,951
1948	3,357	10,278	5,151
1949	3,313	10,001	5,558
1950	3,857	14,445	6,433
1951	3,685	13,124	8,897
1952	2,939	13,496	9,403
1953	3,126	14,333	10,313
1954	3,786	15,715	11,196
1955	4,596	18,971	12,223
1956	4,681	17,924	13,393
1957	4,223	17,081	14,196
1958	4,231	18,893	13,328

a/ Omitting highways, dams, and other heavy engineering construction.

Sources: Facts For Industry and Construction Review.

Estimation Equation $Y = 1,262.0465 + 0.209995X_1 - 0.060339X_2$

Correlation of Coefficient (R) = 0.91

Standard Error of the Estimate S = 296 thousand units.

Appendix B

FORECAST FOR THE U. S. TOILET SEAT MARKET

Year	Residential Construction[a]	Non-Residential Construction[a]	Shipment of Water Closet Bowls[b]	Shipment of Toilet Seats[c]
	(million dollars)		(thousand units)	
1960	20,400	16,457	4,553	9,106
1965	23,300	19,231	4,994	9,988
1970	26,300	20,900	5,524	11,048

a/ Forecast by Walter Kennon and William E. Durrett, Vitreous China Sanitary Ware: A Manufacturing Opportunity in Georgia, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia, July 1959.

b/ Forecast based on the multiple correlation with residential and non-residential constructions.

c/ Forecast based on the current ratio of toilet seat shipment and water closet bowl shipment (2:1).

Appendix C

ESTIMATE OF THE TOILET SEAT REGIONAL MARKET, 1960

The U. S. toilet seat market is estimated at 9,106,000 units in 1960. This figure will be equally shared by the new building market and the replacement market. The percentages of construction expenditures and the percentages of all dwelling units in the six southeastern states to the U. S. totals are presented in the following.

State	Construction Expenditure[a]	All Dwelling Units[b]
Alabama	1.0	1.8
Florida	5.0	2.1
Georgia	1.5	2.1
North Carolina	1.0	2.3
South Carolina	0.5	1.2
Tennessee	1.0	2.0
Total	10.0	11.5

a/ Walter Kennon and William E. Durrett, op. cit.

b/ 1950 Housing Census

Market for new constructions 4,553,000 × 10% = 455,300 units
Market for replacements 4,553,000 × 11.5% = 523,595 units
Regional total 978,895 units

Appendix D

AVAILABLE WOOD RESIDUES OF FIFTEEN WOODWORKING CONCERNS IN GEORGIA, SEPTEMBER 1959

Name and Address	Wood Species	Separated by Species		Forms	Free of Bark	
		Yes	No		Yes	No
Talley Veneer & Crate Co., Adel	Gums, magnolia bay, poplar, maple	×		Sawdust, slabs, chips	×	
A. R. Abrams, Inc., Atlanta	Maple, white pine, poplar, gum, fir		×	Sawdust, shavings	×	
Suwannee Mill, Inc., Baxley	Gum, bay, poplar, maple, ash		×	Chips	×	
International Furniture Co., Cornelia	Oak, gum, maple		×	Sawdust, shavings, chips		×
Sparta Furniture Mfg. Co., Sparta	Poplar	×		Sawdust, shavings, short ends	×	
Campbell Lumber Co., Atlanta	Yellow pine, oak, poplar		×	Sawdust, shavings slabs	×	
Richmond Lumber Co., Augusta	Maple, gum, poplar	×		Sawdust, shavings, slabs, chips	×	
Zimmerman Mfg. Co., East Point	Poplar, ash, gum, oak, hackberry		×	Sawdust	×	
Chattanooga Furniture Co., Flowery Branch	Poplar, gum		×	Sawdust, slabs	×	
Union Timber Corp., Homerville	Pine	×		Sawdust	×	
Cordele Sash, Door & Lumber Co., Cordele	Yellow pine	×		Sawdust	×	
Georgia Cushion & Wrapper Co., Woodland	Yellow pine	×		18" blocks	×	
George Allen Co., Clyo	Yellow pine	×		Sawdust, shavings, slabs		×
Lyles Novelty Works, Barnesville	Maple, magnolia, elm		×	Sawdust, shavings	×	
Monticello Bobbin Co., Monticello	Sugar maple	×		Sawdust, shavings	×	

Appendix D (cont.)

Name and Address	Moisture Content Per Cent	Quantity Available Per Week	Could Contract for a Long Term Supply Yes	No	Remark
Talley Veneer & Crate Co., Adel	50	300 tons or more: Gums 80%, bay 10%, poplar & maple 10%	×		Similar materials in quantity are available in vicinity
A. R. Abrams, Inc., Atlanta	6 to 10	21 to 28 truck loads			Free for hauling off
Suwannee Mill, Inc., Baxley	50	100 tons	×		
International Furniture Co., Cornelia	6 to 10	140 tons			
Sparta Furniture Mfg. Co., Sparta	8	20 tons	×		
Campbell Lumber Co., Atlanta	Green	65 tons: yellow pine 80%	×		
Richmond Lumber Co., Augusta	Green	Waste from 5,000,000 Bd. Ft. of lumber annually	×		
Zimmerman Mfg. Co., East Point	10 to 12	1,500 pounds	×		
Chattanooga Furniture Co., Flowery Branch	6 to 8	4 to 6 tons			
Union Timber Corp., Homerville	40 to 50	75 tons	×		Similar materials more than 150 tons available weekly in vicinity
Cordele Sash, Door & Lumber Co., Cordele	Green	40 tons	×		
Georgia Cushion & Wrapper Co., Woodland	12 to 20	30 cords	×		
George Allen Co., Clyo	Green	Waste from 40,000 Bd. Ft. of lumber weekly	×		
Lyles Novelty Works, Barnesville	6	Several truck loads		×	
Monticello Bobbin Co., Monticello	4 to 9				125 to 150 tons available at hand